PATENT
D-2K041

# POINT SOURCE MICROSCOPE:
# DEVICE, METHODS AND ASSEMBLY PROCEDURES

INVENTORS:
Robert E. Parks
William P. Kuhn

# POINT SOURCE MICROSCOPE: DEVICE, METHODS AND ASSEMBLY PROCEDURES

## CROSS-REFERENCE TO RELATED APPLICATION

**[0001]** The present application is a non-provisional application and claims priority from provisional application Serial No. 60/241,914, filed on October 19, 2000.

## TECHNICAL FIELD

**[0002]** The present invention is directed to alignment and inspection of optical systems and precision mechanics and in particular addresses the need to relate mechanical or optical datums to themselves or each other.

## BACKGROUND ART

**[0003]** Opticians have long made use of a point source of light for the testing of optical components. Among the earliest of tests is the "Star Test" as described by W.T. Welford in Optical Shop Testing, Daniel Malacara, editor, 2nd edition, John Wiley & Sons, pp. 397-398 (1992). In this test, a point source of light is used as the source for an optical system and the image produced by the system is examined to estimate the type and size of the defects in the optical component or system. The Foucault knife-edge test also utilizes a point source of light and a sharp edge to locate the center of curvature of a surface and is also described in by J. Ojeda-Castañeda in Optical Shop Testing, supra, pp. 265-270.

**[0004]** At least as early as 1972, a point source eyepiece was made and used in a microscope by Ray Boyd at Frank Cooke, Inc. Mr. Boyd started with a fiber optic preform, a 1/8 inch cylinder of glass that was designed for drawing into a glass fiber. The preform was partially drawn, the fiber bent and the tip cleaved. The portion of the preform that was not drawn provided a convenient means for light input. An eyepiece with fiber is shown in FIG. 1.

**[0005]** Parks has described a variation on the manufacturing method of a point source for optical testing using glass fibers rather than a fiber optics preform; see, R.E. Parks, "Bright, inexpensive pinhole source", Applied Optics, Vol. 17, No. 16, p. 2469 (1978).

**[0006]** A schematic diagram of a typical microscope is shown in FIG. 2. A real, magnified image of the sample is produced by the objective at the reticle plane, which is the front focal plane of the eyepiece. The eyepiece further magnifies the image at the reticle plane for visual observation. The microscope may be of finite or infinite conjugate design. It is possible to place a detector (e.g., CCD camera) at the reticle plane in place of an eyepiece or at any location behind the objective in conjunction with suitable optics between the objective and detector.

**[0007]** FIG. 1 depicts a point source eyepiece using a carefully fabricated fiber optic component as a point source at the reticle plane of an eyepiece. If a light source, such as a flashlight, is directed at the end of the fiber optic component, then a point source will exist at the reticle plane of the microscope. The microscope objective projects a point of light (i.e., an image of the point source) on to the sample plane. The microscope then produces an image of the illuminated point on the sample at the reticle plane. However, the fiber tip will obscure the return image if the microscope is focused on the surface. If the microscope is not in focus (the sample is displaced from the proper or in focus sample plane), then the image of the point source will be larger than the fiber tip.

**[0008]** The behavior of the point image is different when the microscope is focused near the center of curvature of a spherical object such as a tooling ball, concave or convex mirror or lens, as in FIG. 4a rather than on a surface as shown in FIG. 4b. The point image will be displaced laterally from the fiber tip in proportion to the